

## CLAIMS

- 1    1.     An electro-optical system, comprising:  
2         a plurality of electromagnetic gain media having a corresponding plurality of  
3         apertures thereof disposed in a predetermined spatial distribution;  
4         a refracting surface disposed to intercept energy from the plurality of apertures;  
5         and  
6         a partially reflecting surface to direct portions of the intercepted energy back  
7         toward the plurality of apertures with the directed energy being distributed about the  
8         plurality of apertures.
- 1    2.     The system of Claim 1 wherein such refracting surface is spaced from the  
2         plurality of apertures by approximately one half a focal length of the refracting surface.
- 1    3.     The system of Claim 1 wherein the plurality of apertures have a corresponding  
2         Fourier plane and the apertures are disposed in said Fourier plane.
- 1    4.     The system of Claim 1 wherein the plurality of apertures have a corresponding  
2         Fourier plane and said Fourier plane is overlaid back onto the apertures by means of the  
3         refracting surface and the partially reflecting surface.
- 1    5.     The system of Claim 1 wherein the plurality of apertures have a corresponding  
2         spatial frequency plane and the plurality apertures are disposed in said spatial frequency  
3         plane.
- 1    6.     The system of Claim 1 wherein the gain media is at least one of  
2         a diode pumped fiber laser;  
3         a fiber coupled diode laser;

- 4 a gas laser;
- 5 a diode pumped solid state laser; and
- 6 a monolithic laser diode array.

1 7. The system of Claim 6 wherein the diode pumped solid state laser is at least one  
2 of:

- 3 a Nd:YAG laser;
- 4 a Ruby laser;
- 5 a Nd: YLF; and
- 6 a Ho:YAG.

1 8. The system of Claim 1 further comprising:  
2 a cavity having a first surface; and  
3 wherein the plurality of apertures is disposed on said first surface to couple  
4 radiation from the plurality of gain media into said cavity.

1 9. The system of Claim 8 at least one spatial Fourier transform of a pattern of the  
2 intercepted energy is achieved upon a single round trip through the external cavity.

1 10. The system of Claim 9 wherein the at least one Fourier transform of the pattern is  
2 overlaid on itself.

1 11. The system of Claim 9 wherein the plurality of apertures is disposed in a  
2 predetermined spatial distribution such that a corresponding intercepted energy pattern  
3 has a plurality of intensity peaks at corresponding locations of the at least one Fourier  
4 transformed intensity pattern that is achieved through the action of the cavity.

1 12. The system of Claim 1 wherein the spatial distribution is predetermined such that  
2 the energy being distributed about the plurality of apertures of the gain media is initially

3 directed to a plurality of frequency conversion devices.

1 13. The system of Claim 12 wherein the frequency conversion devices are frequency  
2 doubling crystals.

1 14. The system of Claim 1 wherein the predetermined spatial distribution provides a  
2 spatial filter establishing a composite beam comprised of energy from the plurality of  
3 gain media with phase coherency.

1 15. The system of Claim 14 wherein the refracting surface is closer to the partially  
2 reflecting surface than a Talbot distance  $2D^2/\lambda$ , where  $\lambda$  is a nominal wavelength of the  
3 composite beam and D is a spacing between each of the plurality of apertures and a  
4 corresponding nearest neighboring aperture.

1 16. The system of Claim 1 wherein the refracting surface is a lens.

1 17. The system of Claim 1 wherein the partially reflecting surface is a mirror.

1 18. The system of Claim 1 wherein the refracting surface is adjacent to the partially  
2 reflecting surface.

1 19. The system of Claim 1 wherein the regions of constructive interference are  
2 disposed on the apertures producing an output of the system a composite beam comprised  
3 of energy from the plurality of gain media with phase coherency.

1 20. The system of Claim 1 wherein the predetermined spatial distribution provides a  
2 spatial filter establishing a composite beam by combining in parallel the energy from  
3 each of the plurality of gain media.

1 21. The system of Claim 1 wherein the plurality of apertures includes N apertures  
2 where N is greater than two.

1 22. The system of Claim 21 wherein portions of the intercepted energy is directed to  
2 each of the plurality of N apertures.

1 23. The system of Claim 1 wherein the plurality of apertures are located in  
2 corresponding Fourier planes.

1 24. The system of Claim 1 wherein the refracting surface and the partially reflecting  
2 surface direct the energy emitted from the each of the plurality of apertures, substantially  
3 over the plurality of apertures.

1 25. The system of Claim 1 wherein the plurality of apertures is disposed such that an  
2 interference pattern of the energy has a plurality of relatively high intensity spots at  
3 substantially the same position as a plurality of the energy.

1 26. The system of Claim 1 the energy has an input spatial pattern which has a  
2 relatively high degree of coupling with a Fourier transform of the input energy spatial  
3 pattern.

1 27. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution;  
4 a common optical element disposed to intercept energy from the plurality of  
5 electromagnetic gain media and partially direct the energy back toward the plurality of  
6 apertures of the plurality of gain media with the directed energy being distributed about  
7 the plurality of gain media; and  
8 wherein the predetermined spatial distribution provides a spatial filter establishing

9 a composite beam comprised of energy from the plurality of gain media with phase  
10 coherency.

1 28. The system of Claim 27 wherein the composite beam is a laser beam.

1 29. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution;  
4 a common optical element disposed to intercept energy from the plurality of  
5 electromagnetic gain media forming an interference pattern across the apertures, such  
6 interference pattern having regions of constructive interference and regions of destructive  
7 interference; and  
8 wherein the regions of constructive interference are disposed on the apertures  
9 producing an output of the system a composite beam comprised of energy from the  
10 plurality of gain media with phase coherency.

1 30. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution;  
4 a common optical element disposed to intercept energy from each of the plurality  
5 of electromagnetic gain media and direct the energy from each of the plurality of gain  
6 media back toward the plurality of apertures of the plurality of gain media with the  
7 directed energy being distributed about the plurality of gain media; and  
8 wherein the predetermined spatial distribution provides a spatial filter establishing  
9 a composite beam by combining in parallel the energy from each of the plurality of gain  
10 media.

1 31. The system of Claim 30 wherein the composite beam is a composite phase  
2 coherent laser beam.

1 32. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution;  
4 a common optical element disposed approximately to intercept energy from the  
5 plurality of electromagnetic gain media and direct the energy back toward the plurality of  
6 apertures of the plurality of gain media with the directed energy being distributed about  
7 the plurality of gain media, such common optical element comprises a lens adjacent to a  
8 partially reflecting surface.

1 33. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution;  
4 a common optical element disposed approximately to intercept energy from the  
5 plurality of electromagnetic gain media and partially direct the energy back toward the  
6 plurality of apertures of the plurality of gain media with the directed energy being  
7 distributed about the plurality of gain media, such common optical element comprises a  
8 Fourier transform lens adjacent to a partially reflecting surface.

1 34. An electro-optical system, comprising:  
2 a plurality of electromagnetic gain media having apertures thereof disposed in a  
3 predetermined spatial distribution having a spacing  $D$ ;  
4 a common optical element having a refracting surface and a partially reflecting  
5 surface, and to direct the energy back toward the plurality of apertures of the plurality of  
6 gain media with the directed energy being distributed about the apertures, such common  
7 optical element being spaced apart from the apertures to intercept energy from the  
8 plurality of electromagnetic gain media by approximately a distance  $D^2/\lambda$ , where  $\lambda$  is a  
9 nominal wavelength of an output beam.

1 35. An electro-optical system, comprising:

- 2 a plurality of electromagnetic gain media having a corresponding plurality of  
3 apertures thereof disposed in a predetermined spatial distribution;  
4 a common optical element comprising:  
5 a refracting surface disposed to intercept energy from the plurality of  
6 apertures;  
7 a partially reflecting surface to direct a portion of the intercepted energy  
8 back toward the plurality of apertures with the directed energy being distributed among  
9 the plurality of apertures; and  
10 such common optical element being spaced apart from the plurality of apertures  
11 by approximately one half a focal length of the common optical element.
- 1 36. The system of Claim 35 wherein the common optical element is a reflector having  
2 optical power.
- 1 37. The system of Claim 36 wherein the reflector comprises a lens disposed on a  
2 partially reflective surface.
- 1 38. The system of Claim 37 wherein the reflector partially reflects the directed energy  
2 and partially transmits the directed energy to form an output beam.
- 1 39. A cavity for combining electromagnetic energy from a plurality of  
2 electromagnetic gain media having a corresponding plurality of apertures, comprising:  
3 a housing having a first surface;  
4 a plurality of slots disposed on said first surface in a predetermined spatial  
5 distribution to receive the plurality of electromagnetic gain media;  
6 a common optical element disposed to intercept energy passed through the  
7 plurality of apertures; and  
8 wherein the predetermined spatial distribution provides a spatial filter establishing  
9 a composite beam comprised of energy from the plurality of gain media with phase

10 coherency.

- 1 40. A method to produce a phase coherent beam comprising:
  - 2 providing a plurality of apertures for a plurality of electromagnetic gain media
  - 3 producing a plurality of radiation beams;
  - 4 providing a refracting surface and a partially reflecting surface disposed to reflect
  - 5 portions of the radiation beams;
  - 6 spacing each of the plurality of apertures apart in a predetermined spatial
  - 7 distribution to provide a spatial filter establishing a composite beam comprised of energy
  - 8 from the plurality of gain media with phase coherency.